2016 Annual Report for NREC Project-02437

Nitrogen Management Systems in Tile-Drained Fields: Optimizing Yields while Minimizing Losses

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Objectives

The overall goal of this project is to more fully understand current and new nitrogen management systems on corn yields and nitrate losses from tile-drained fields in Illinois.

Specific objectives are to:

1. To conduct on-farm field trials of current and new N management systems for typical corn/soybean rotations, evaluating both the yield response and the tile losses of nitrate.
2. To determine when and why tile nitrate losses occur in these management systems, during both corn and soybean rotations.

This report summarizes results from the second complete year of the project.

Treatments

1. Full rate of NH_3 (160 lb N/acre) applied in the fall after November 1 with nitrapyrin.
2. 80 lb N applied as NH_3 in the fall with nitrapyrin followed by 40 lb N/acre as UAN at planting followed by 40 lb side-dressed as UAN.
3. Full rate applied as NH_3 (no nitrapyrin) in early spring (to before planting), with placement between rows by RTK.
4. Reduced rate (120 lb N/acre) applied as NH3 (no nitrapyrin) in early spring (before planting), with placement between rows by RTK.
5. 80 lb N applied as NH_3 early spring (before planting) followed by 80 lb N as UAN side-dressed.
6. Treatment #5 but with cover crops (oats-radish mixture seeded into standing soybean crop the previous early fall; cereal rye after corn).

Methods

- 6 treatments (treatments listed below) with 3 replicates
- Both phases of the corn and soybean rotation every year
- 36 tile lines (18 in corn and 18 in soybean)
- Plots are 100 feet wide (50 ft on each side of 5 inch lateral) and 4.5 A in area
- Randomized complete block design (6 blocks/6 treatments)

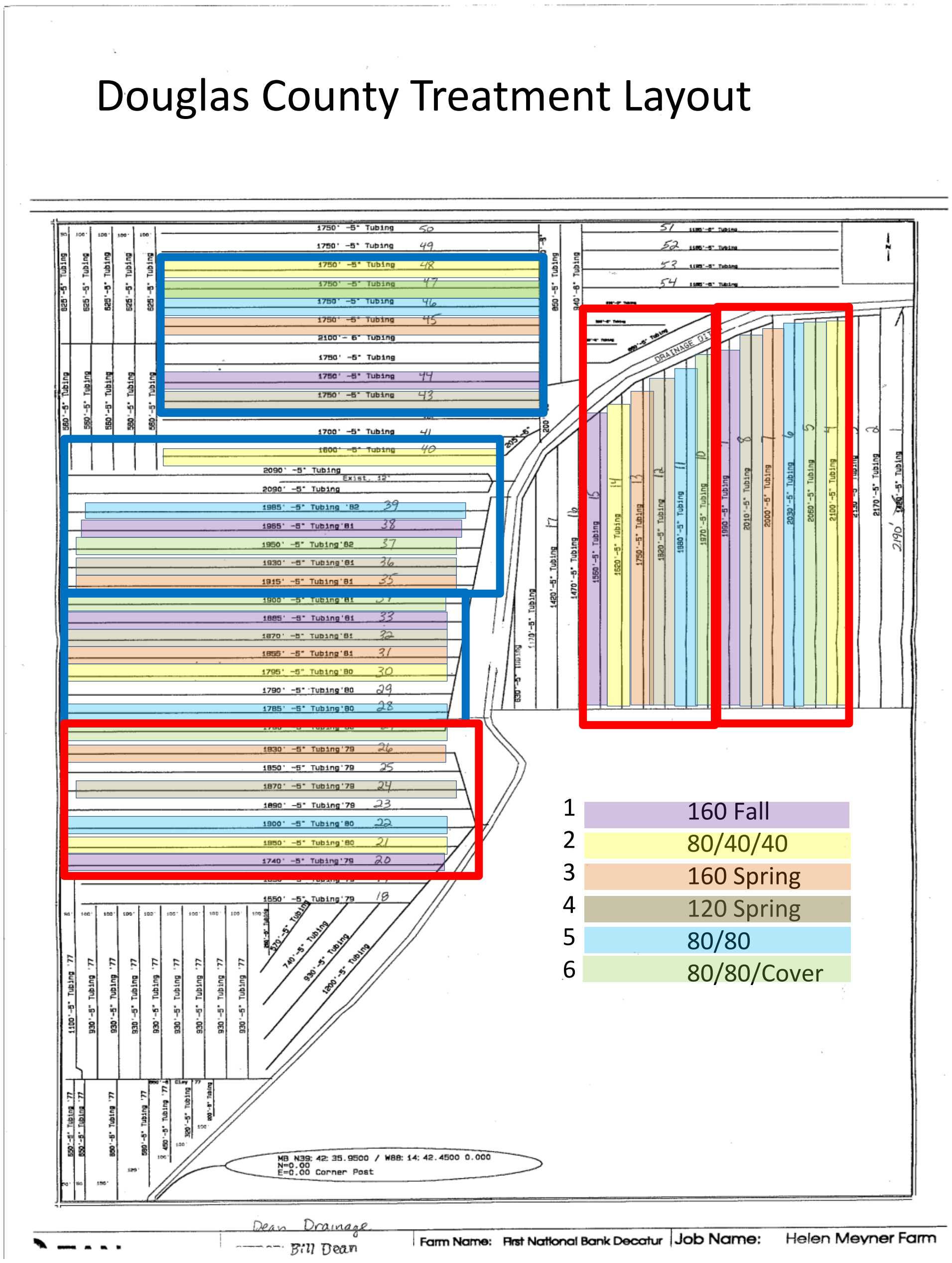

Figure 1. Tile map and experimental design with corn plots outlined in blue and soybean plots outlined in red for 2016.

Corn plots: Fall N was applied on Nov. 15, 2015. Spring N was applied on April 19, 2016. Side-dress N occurred on June 14, 2016. Cereal rye was terminated on April 29, 2016. Corn was planted on May 21 and yield rows (center 8 rows) were harvested on October 4 and 5.

Soybean plots: Soybean was planted on May 29 and harvested on October 27 of 2016.

Tile Nitrate Concentration Results:

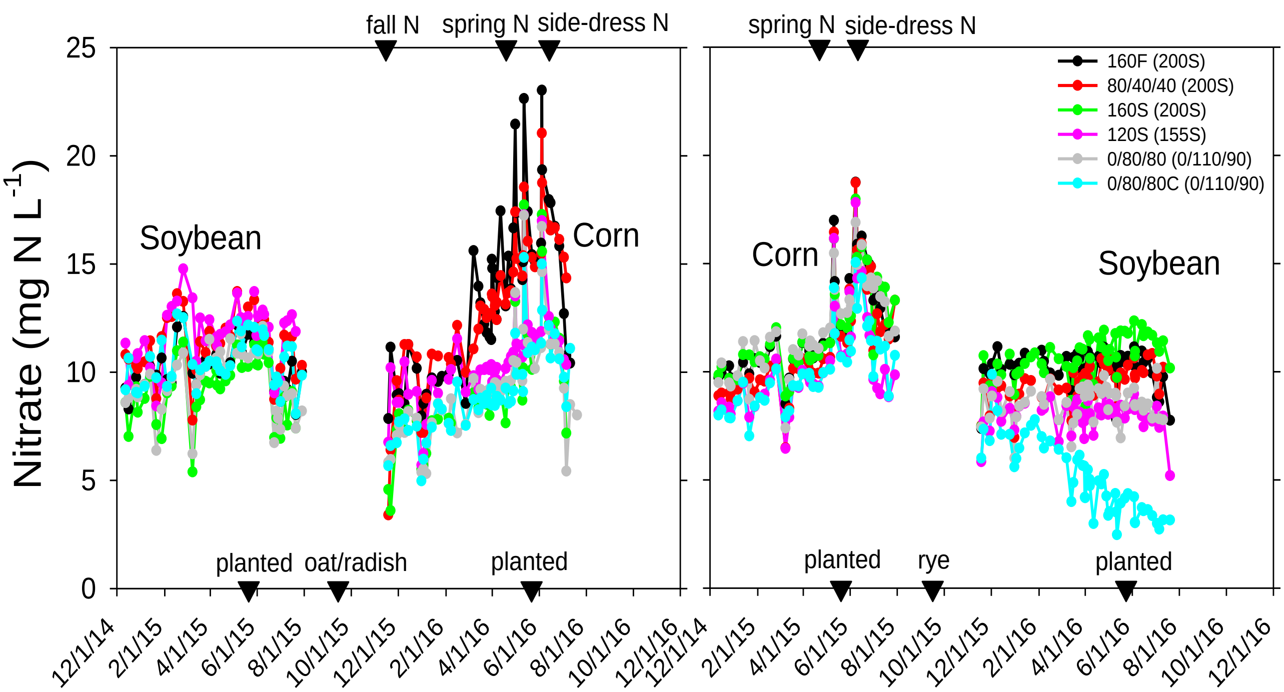

Figure 2. Tile nitrate concentrations from each of the 6 N treatments from December of 2014 through September of 2016. Each dot is the average of the three replicates. 200 lbs of N/A was applied to corn for the 2015 growing season and 160 lbs of N/A was applied to corn for the 2016 growing season.

Tile nitrate concentrations were elevated throughout the spring and summer for plots receiving fall N compared to those that did not receive fall N. There was also an increase in tile nitrate concentrations following spring applied N; however, nitrate concentrations remained greater throughout the entire drainage season for plots that received fall N (Figure 2).

Tile nitrate concentrations were reduced for plots with cereal rye after corn compared to those without the cover crop. Tile nitrate concentrations remained on average at about 10 ppm for soybean plots without the cover crop.

The oat and radish biomass and biomass N were not sufficient to significantly decrease tile nitrate concentrations. Cover crop biomass and biomass N for oat and radish was 0.22 tons/A and 11 lbs/A and for cereal rye was 1.26 tons/A and 32 lbs/A, respectively. This suggest spring growth is very advantageous for overwintering cover crops like cereal rye compared to those that winter kill. The effect of the cereal rye cover crop on tile nitrate concentration became apparent in late February and continued throughout the row crop growing season (Figure 2).

Tile Nitrate Loads for Corn Plots:

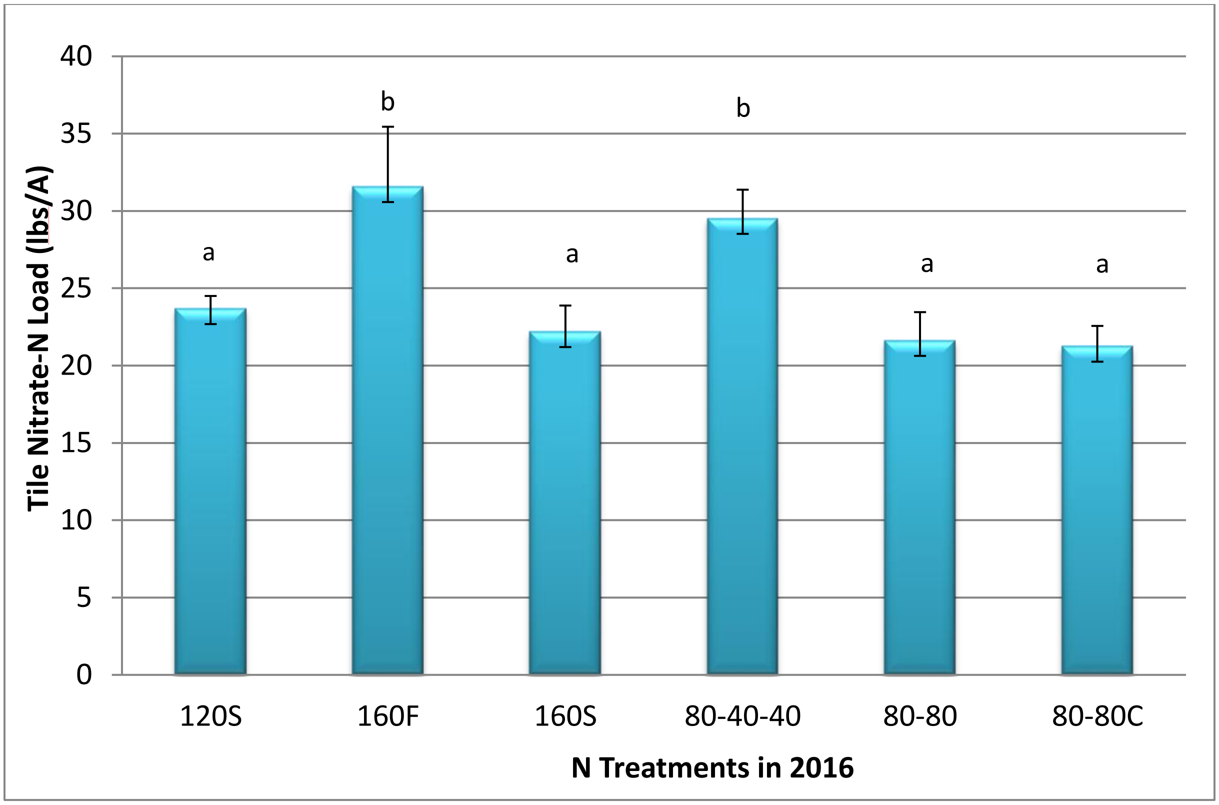

Figure 3. Tile nitrate load from the 6 N treatments on corn in 2016. Change in letters indicate significant treatment differences ($p<0.05$).

Tiles draining plots that received fall fertilizer N (either full rate or half rate) carried significantly more nitrate than tiles draining the other four treatments. It is interesting to note that treatments with split applications of fertilizer N did not decrease N loss compared with spring only application. Also, the reduced fertilizer N rate treatment did not decrease N loss compared with the spring only application.

Overall, fall fertilizer N application lost approximately 35% more N than spring fertilizer N application. The 8 to 10 lbs of nitrate-N/A loss from fall N equates to a cost of only $3 or $4/A at today's price of anhydrous ammonia. Based on a farmer's bottom line, this would not be a compelling reason to refrain from applying fertilizer N in fall. However, this amount of N loss is considered to have undesirable effects on local water quality and ultimately contributes to the development of a seasonal hypoxic zone in the Gulf of Mexico.

Flow weighted mean nitrate concentration values for the two fall fertilizer N treatments were above 10 ppm (approximately 13 ppm), while all other treatments were slightly below 10 ppm (data not shown).

Corn Grain Yields in 2016:

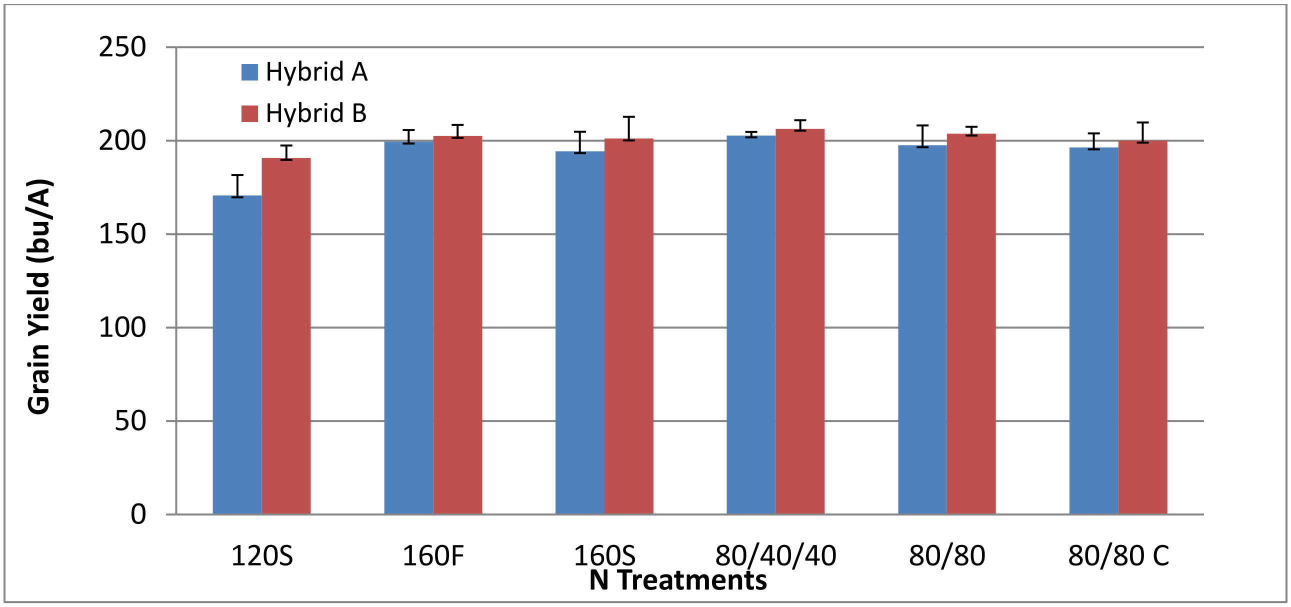

Figure 4. Corn grain yield across the 6 treatments for two hybrids in 2016.

Corn grain yield was not significantly different for any of the full N rate treatments, but was significantly lower for the reduced rate treatment (120 lbs of N/A). Note: two hybrids were planted in 4 row swaths across all plots in 2016. Corn yields peaked at approximately 205 bu/A, while the reduced rate produced corn yields of about 10 bu/A less for one hybrid and 25 bu/A less for the other hybrid (Figure 4).

Tile Nitrate Loads for Soybean Plots:

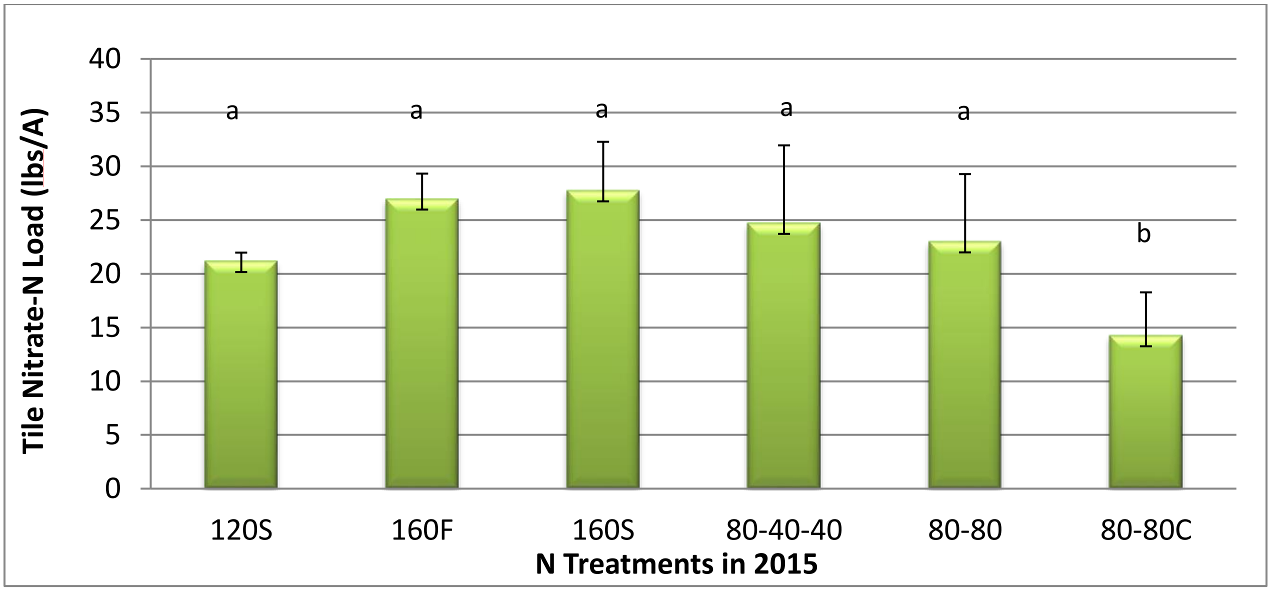

Figure 5. Tile nitrate load from soybean plots in 2016 with 2015 N treatments identified. Change in letters indicate significant treatment differences ($p<0.05$).

Tile nitrate-N loads were not significantly different across treatments except for the cover crop treatment (cereal rye after corn) (Figure 5). Although not significantly different, the reduced N fertilizer rate treatment from 2015 tended to have lower tile N loss than the full rate fertilizer N treatments from 2015. If this trend continues then the reduced fertilizer rate treatment may separate itself from the full rate treatments over time. The tile nitrate load was approximately 40% less for cereal rye after corn compared to the companion treatment with no cover crop (80-80). This represents a load reduction nearly equal to the EPA goal of reducing nitrate export from states throughout the Mississippi River Basin by 45%.

Soybean Grain Yields in 2016:

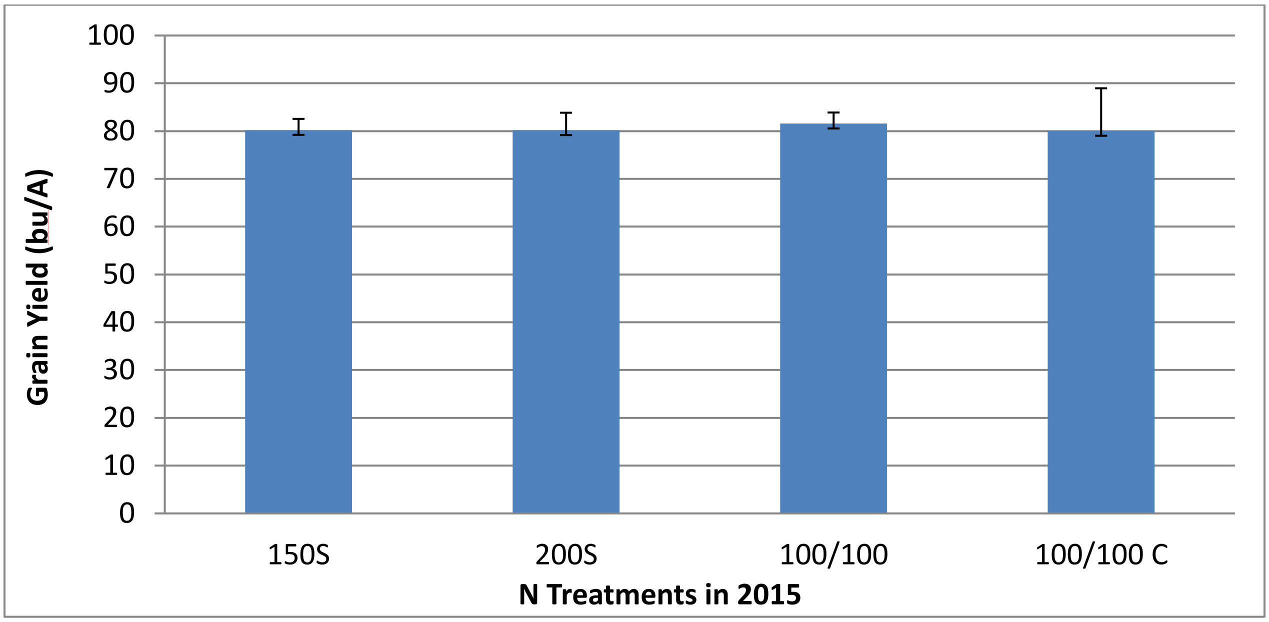

Figure 6. Soybean grain yield in 2016 across the 4 treatments initiated in 2015. Note: the fertilizer N rates for corn were greater in 2015 due to the presence of corn on the entire study area in 2014.

The soybean crop greatly benefitted from ample rainfall in July and August of 2016 and all treatments averaged approximately 80 bu/A. There were no significant differences for soybean yield across treatments.

The cereal rye cover crop planted after corn did not interfere with soybean production. This suggest that cereal rye after corn and before soybean may be one of the best solutions for greatly decreasing tile nitrate concentrations and loads without sacrificing soybean grain yield.

This year's soybean crop was driven over by the Hagie seeder in early September to plant oats and radish. Based on the width of the Hagie tires, the seeding of oat and radish into standing soybean reduced the plot yields by about 2 bu/A. However, we did not take this yield reduction into account in Figure 6. Here we are showing the biological potential of the soybean crop following cereal rye (excluding the mechanical damage from the Hagie seeder).

N Rate Trial in 2016

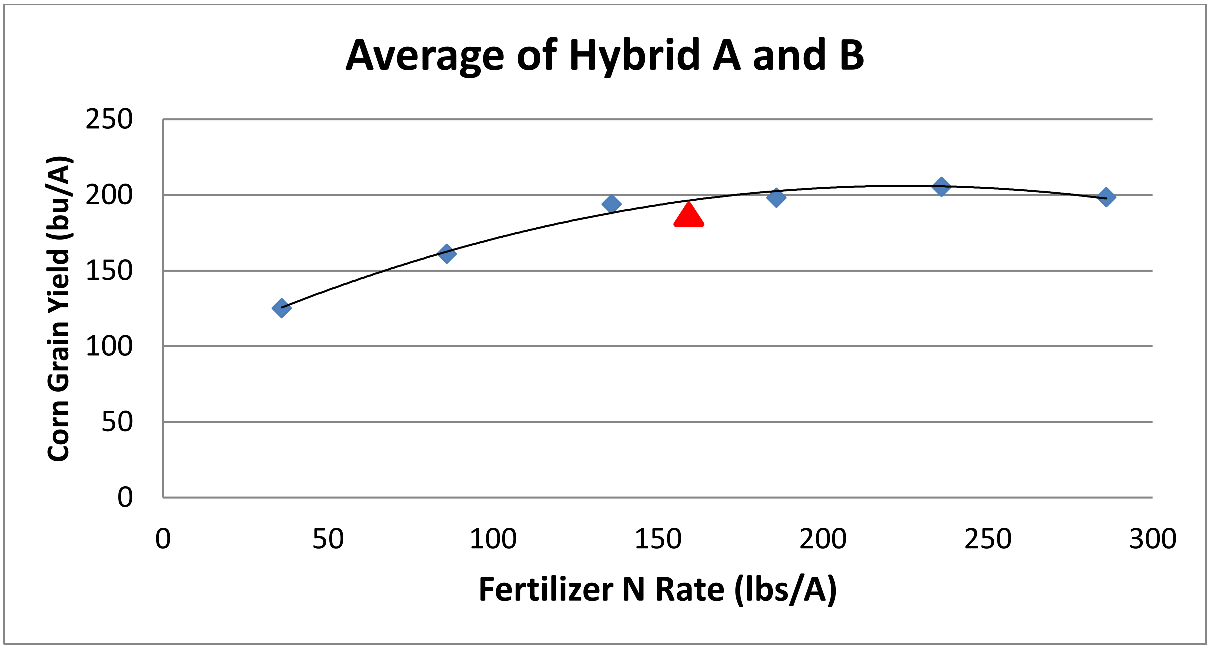

Figure 7: Corn grain yield and economic optimum N rate under 6 N rates (36, 86, 136, 186, 236, and 286 lbs/A).

This year a N rate trial was established on site under conditions representing Treatment 3 (160 lbs of N/A in the spring). N rates included were: 0, 50, 100, 150, 200, 250 lb of N/A; however, DAP was applied at a rate of 200 lbs/A, which adds 36 lbs of N/A to each N rate for final N rates of 36, 86, 136, 186, 236, 286 lbs/A. Dan Schaefer (IFCA) was instrumental in setting up the N rate study and harvested plots. The EONR was nearly the same as the MRTN suggested rate of 160 lbs/A

Highlights in 2016

- Cereal rye growth and N uptake was sufficient to impart an effect on the tile nitrate concentration (nitrate concentration decreased to approximately 3 ppm), while tile nitrate was approximately 10 ppm for the remainder of the soybean plots in 2016.
- Cereal rye after corn (before soybean) decreased tile nitrate load by approximately 40% without sacrificing soybean yield.
- There was little difference between spring fertilizer N application and the spring plus side-dress treatments for corn grain yield or tile nitrate loss.
- Fall fertilizer N treatments showed increased tile nitrate loads (approximately 33% more).
- Above average temperatures in December of 2015 and during the winter and spring of 2016 negatively impacted tile nitrate loss for fall N treatments, but positively impacted cereal rye growth.

We thank NREC for their continued support of this research. Overall, we are pleased with the 2016 results as this year represents the first full year of drainage data following the desired "previous" crop.

This study will provide needed information on nitrogen management systems and resulting tile nitrate losses while supporting high-yielding row crop agriculture.